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To Dr. D. Mills
Director of Research

EVALUATION OF ONTARIO HYDRO RESEARCH DIVISION HTDX2 TIME-DELAY-ON-PICKUP RELAY

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Test results are presented on the evaluation of an Ontario Hydro Research type HTDX2 electronic time delay relay. The relay is intended for use in standard protection specifications as a replacement for the ABB type RXKN timer relay which is no longer available. The HTDX2 relay performed according to the design specifications on all accounts.

Laboratory tests were conducted on the Ontario Hydro Research designed HTDX2 relay. This relay is being considered for use in standard protection specifications for general use in generator and transformer stations. The test results from this investigation are documented in this report.

1.0 DESCRIPTION OF THE HTDX2 RELAY

1.1 General

The HTDX2 relay was designed by the Research Division in order to provide a universal timer relay that would have a large range of operating times and the ability to function within a wide range of supply voltage. Presently available timer relays require the stipulation of a specific operating voltage and timing range.

1.2 Principles of Operation

The HTDX2 is a dc voltage operated timer relay which provides an adjustable time delay on pickup. When the supply voltage is applied to the relay the internal clock begins to generate pulses at a frequency of 1.6384 MHz. The divider/counter circuitry counts the pulses and depending on the relay setting activates an output relay when the desired time delay is achieved. The HTDX2 employs solid state electronic circuitry in the form of an Application Specific Integrated Circuit (ASIC) to provide the frequency division for the timing function. The frequency of the clock circuit is crystal controlled to assure stable and repetitive time delays /1/.

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There is only one model of the HTDX2 relay available; however, this model provides pickup time delays from 0.01 to 2550 s and operates on a range of supply voltages from 38 to 280 Vdc. The relay comes complete with two form 'c' type output contacts. There are no indicators or flags to identify the occurrence of an operation.

The timing characteristics of the HTDX2 relay are set by means of a single 10 position DIP switch located on the relay's main component board. The switch provides 8 binary type settings which range from 1 to 128 (2^0 to 2^8) and 2 multiplier switches which allow settings of 0.01, 0.1, 1.0 or 10.0 s. The relay is normally protected by a Plexiglas cover which must be removed to change the timer settings. Some of the setting switches could be set for the same time delay using various combinations. For example, a delay of 2.0 s could be obtained from a combination of 0.01 x (128+64+8) or 0.1 x (16+4). Various combinations were used in the testing procedure with no noticeable difference in timing characteristics.

The technical specifications outlined in the designer's instruction manual /1/ are reproduced in Appendix I (pages 8 and 9). Photographs of the relay are presented in Appendix II (page 11).

2.0 TEST RESULTS

The HTDX2 was tested under various operating conditions to determine the relay's performance and how it compares with the specifications presented in the instruction manual.

2.1 Performance of the Timing Unit

The specified setting error of the HTDX2 relay is ± 0.01% of setting plus (10 ± 2) ms. The minimum setting resolution is 1 part in 255 of full scale /1/. The operating times obtained from tests conducted at nominal conditions of 125 Vdc and 25°C are given in the table below.

Setting	Operating Time	Operating Time Less Setting	Max. Allowable Excursion	
			from	to
10.0 ms	21.00 ms	11.0 ms	+8.0 ms	+12.0 ms
50.0	61.00	11.0	+8.0	+12.0
100.0	111.00	11.0	+8.0	+12.0
1.0 s	1.01 s	11.0	+8.0	+12.0
10.0	10.01	10.0	+7.0	+13.0
100.0	100.02	20.0	-2.0	+22.0
1000.0	1000.09	90.0	-92.0	+112.0
2550.0	2550.19	190.0	-247.0	+267.0

The results in the table above indicate that the operating times of the HTDX2 relay are offset from the setting times by amounts that are within the design specification.

Temperature tests conducted at +55°C and -25°C produced no significant deviations from nominal test results. The specified time deviation per °C is less than ± (0.005% of setting plus 2 ms) which would yield a maximum error of 130 ms at a time delay of 2550 s (42.5 min.). The effect of changing the auxiliary dc voltage to the minimum and maximum operating extremes of 38 and 280 Vdc produced no noticeable effect on the timing characteristics of the relay. The specified error in timing due to voltage deviations is less than ± (0.001% of setting plus 2 ms).

2.2 Reset Time

The reset time of the relay is the time required for the output contacts to open after the supply voltage has been removed. The design specifications state that a maximum of 18 ms is required for the contacts to reset to their normal (de-energized) state. Tests conducted on the HTDX2 relay indicated an actual maximum reset time of 17 ms, which is within the specifications.

2.3 Recovery Time

The recovery time of a relay is defined as the time necessary for the relay to "reset from an operated or partially operated condition such that succeeding operations have characteristics within the specifications" /1/. The specifications for the HTDX2 relay state that a minimum recovery time of 20 ms at 125 Vdc is required in order to ensure reliable operation on the next timing cycle under conditions when the relay is either timing or picked-up. (See page 9 of Appendix I for specifications at other supply voltages.) Tests were conducted in the laboratory to determine the actual recovery times of the HTDX2 relay at various operating voltages. The tests were conducted by first energizing the relay, then de-energizing the relay after a delay (e.g. 5 ms in first row of table), and then re-energizing the relay after another delay (ex. 5 ms in first row of table). The operating time of the relay was determined from the last re-energization of the relay until the relay output contacts closed. In brief, the tests amounted to dropping the relay out for a short period of time either during or after its timing cycle and determining the effect on the timing of the relay. The following results indicate the relay's performance under these conditions at 125 Vdc and 25°C.

	Relay Setting	Supply Voltage Off After.....	Supply Voltage On After.....	Operating Time of Relay	
Relay Timing	10.0 ms	5 ms	5 ms	9-10 ms	
			10	5-6	
			15	20	(expected time)
	100 ms	50 ms	5 ms	54 ms	
			15	45	
			20	110	(expected time)
	1.0 s	0.7 s	5 ms	0.305 s	
			15	0.295	
			20	1.01	(expected time)
Relay Operated	10.0 ms	100 ms	10 ms	20-21 ms	(expected time)
			15	20-22	
	100 ms	200 ms	5 ms	110 ms	(expected time)
			10	110	
	1.0 s	1.50 s	5 ms	1.01 s	(expected time)
			10	1.01	

The above results confirm the specifications stating that a recovery time of 20 ms at 125 Vdc is necessary, for both pre- and post-operation, to obtain consistent performance. Post-operation recovery times, however, provide accurate performance down to 5 ms according to the above test results. Similar tests conducted at 48 Vdc and 250 Vdc indicated analogous results.

2.4 Supply Interruption

The instruction manual specifies that the dc supply to the relay may be interrupted, without affecting the timing, by up to 16 ms with a supply voltage of 125 Vdc. This characteristic is a factor in applications where there is the possibility of chattering or dirty contacts on the initializing relay. The results of tests to evaluate the effect of supply interruption are tabulated below. The operating time of the relay is the time from the first initialization of the relay. Specifications for other supply voltages are listed in Appendix I (page 8).

Relay Setting	Supply Voltage Off For.....	Supply Voltage	Operating Time of Relay	
50 ms	8.3 ms	125 Vdc	61 ms	(expected time)
	16.6		60	
	20.0		91	
	25.0		96	
100 ms	13.3 ms	125 Vdc	111 ms	(expected time)
	16.6		111	
	20.0		141	
	25.0		146	
1.0 s	13.3 ms	125 Vdc	1.01 s	(expected time)
	16.6		1.01	
	20.0		1.04	
	25.0		1.05	

The above results indicate that the relay performed within its specification with respect to voltage dropout. Tests conducted at other voltages exhibited similar results.

2.5 Effect of Parallel Loads

Previous tests conducted on electronic timer relays have indicated that they may be adversely affected by parallel capacitive loads /4/. In order to test the effects of external capacitance on the HTDX2 relay we performed timing tests with discrete capacitors connected in parallel with the input circuit of the relay. No adverse effects on the timing characteristics of the HTDX2 relay were detected during this test.

2.6 Radio Interference

Radio interference tests were conducted on the HTDX2 relay according to Ontario Hydro specifications /2/. Two radio sources are used in this test to determine the effect of RF interference on the operation of the relay. One radio is a 5 Watt 460.950 MHz Walkie-Talkie and the other a 15 Watt 49.51 MHz Walkie-Talkie. Tests were conducted at a setting of 10 s with the relay energized and timing in order to determine if RF radiation would affect the accuracy of the setting or cause a maloperation. Results indicated that there were no mal-operations when the relay was tested according to Ontario Hydro specifications. If, however, the 5 Watt radiating source was brought close enough to the relay (a distance of less than the specified 25 cm) the relay would operate prematurely. A slight change in timing characteristics was also observed when the 15 W source was activated at a distance less than 25 cm.

2.7 Relay Burden

The test results listed below indicate the dc burdens of the HTDX2 relay at various supply voltages.

Supply Voltage (Vdc)	Supply Current (mA) with the output relay de-energized/energized	Supply Burden (W) with the output relay de-energized/energized	
		Specified	Measured
48.8	1.3/25.8	0.1/1.3	0.1/1.3
122.9	2.1/12.6	0.3/1.6	0.3/1.6
250.7	3.4/10.3	0.9/2.6	0.9/2.6

These measurements show that the burden characteristics of the HTDX2 relay are within the specified ratings.

2.8 Surge Withstand Capability and Insulation

Surge Withstand Capability of the relay was tested according to Ontario Hydro Standard Specification A-28M-82 /3/. This document details testing to be done with the following criteria:

Magnitude:	0.5, 1.0, 2.5 kV
Frequency:	130, 220, 360, 600 kHz, 1, 1.6 MHz
Repetition Rate:	120 / s
Duration:	4 s

No failures or misoperations were detected when the HTDX2 was tested to these specifications. The insulation level between the dc supply inputs and the output contacts was tested to 1.5 kV, 60 Hz for 60 s with no evidence of breakdown or excessive leakage current. The insulation level across the open contacts was tested to 1.0 kV, 60 Hz for 60 s with no evidence of breakdown or excessive leakage current.

2.9 Contact Performance

The output contacts on the HTDX2 relay were tested at a nominal voltage of 125 Vdc with an inductive load of R=1000 Ω, and L/R=20 ms. The contacts on the output relay are rated for L/R=20 ms and 0.2 A at 125 Vdc. Test results indicated that the output contacts were able to break the load without bouncing or excessive arcing. There is no specific standard that Ontario Hydro uses for evaluating contact performance; however, the HTDX2 contacts exhibited similar performance to contacts of an RXMS type relay which is widely used on the Ontario Hydro system.

3.0 GENERAL COMMENTS

The mechanical construction the HTDX2 relay was very good. There were no noticeable defects with the relay.

4.0 CONCLUSIONS

The HTDX has proved to perform in accordance with the design specifications on all accounts.

ACKNOWLEDGEMENT

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REFERENCES

1. Stelter, M.K.G. "HTDX2 Digital Timing Relay Instruction Manual," Ontario Hydro Research Division Report No. 88-234-K.

2. General Tendering Documents, "Specification for Testing Susceptibility of Electronic Equipment to Radiated Interference," Ontario Hydro Designation No. C-5047-77.

3. Standard Specification, "Oscillatory Transient Interference Immunity Test," A-28M-82, Issued July, 1982.

4. Beresh, R.W. "Evaluation of ASEA RXKC 2H Dropout Time-Delay Relay," Ontario Hydro Research Division Report No. 89-289-H.

APPENDIX I

TECHNICAL SPECIFICATIONS

APPENDIX I

Summary of Technical Specifications /1/

Time Delay Ranges	0.01 to 2.55 s 0.10 to 25.5 s 1.00 to 255 s 10.0 to 2550 s
Setting Resolution	1 part in 255 of full scale
Setting Error	±0.01% of setting + (10±2) ms
Operating Voltage Range	38 to 280 Vdc

Power Consumption

Operating condition:	Timing	Picked Up
consumption at 250 Vdc	0.9 W	2.6 W
consumption at 125 Vdc	0.3 W	1.6 W
consumption at 48 Vdc	0.1 W	1.3 W

Operating Temperature Range	-20 to +55°C
Supply Voltage Influence on Time Delay	±(0.001% of setting + 2 ms) (at operating extremes of 38 and 280 Vdc)
Temperature Influence on Time Delay	±(0.005% of setting + 2 ms) (at operating extremes of -20 and +55°C)
Output Relay Contacts	2 form 'C' type
Contact Material	Silver, cadmium oxide

Contact Rating

Max. Switching Voltage	280 Vdc
Max. Continuous Current	4 A
Making Capacity	10 A for 10 ms

Interrupting Capacity

Supply voltage	250 Vdc	125 Vdc	48 Vdc
dc, L/R=20 ms	0.15 A	0.2 A	0.4 A
(with protection	0.3 A	0.4 A	0.8 A)

Maximum Reset Time 18 ms

Maximum Allowable Supply Interruption

Supply voltage	250 Vdc	125 Vdc	48 Vdc
Maximum interruption	25 ms	16 ms	7 ms

Minimum Recovery Time

Supply voltage	250 Vdc	125 Vdc	48 Vdc
Before output relay picks up	30 ms	20 ms	10 ms
After output relay picks up	25 ms	20 ms	20 ms

Dielectric Strength

Output contacts to dc input	1.5 kV, 60 Hz
Across open contacts	1.0 kV, 60 Hz

Transient Immunity 2.5 kV as per OH Specification A-28M-82

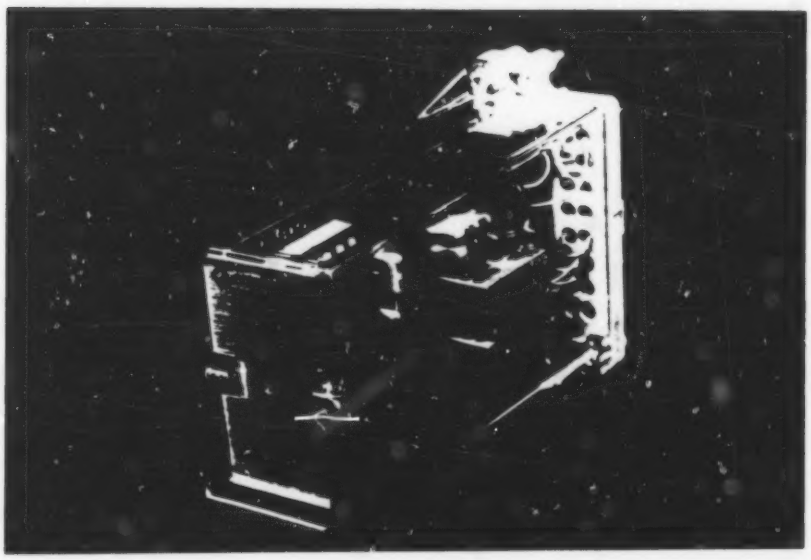
Radio Frequency Immunity As per OH Specification C-5047-77

Case Single seat Combiflex

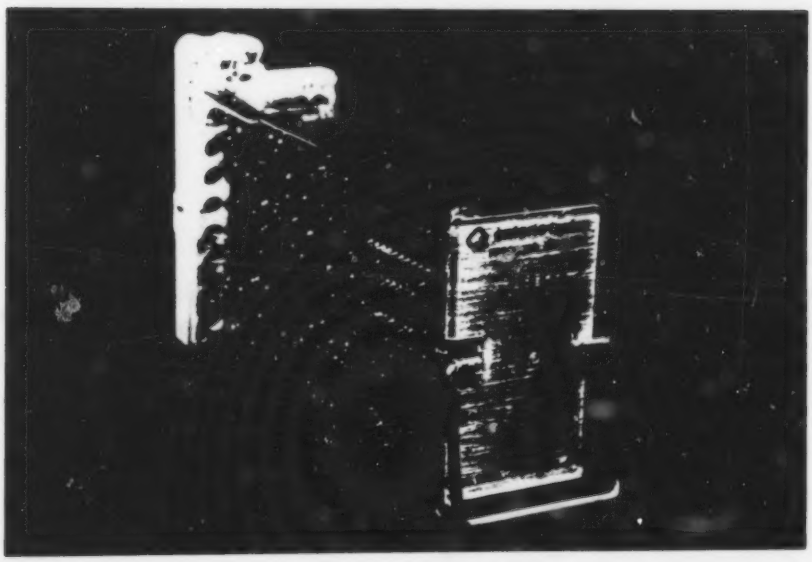
APPENDIX II

HTDX2 RELAY PHOTOGRAPHS

HTDX2 RELAY



RIGHT VIEW



LEFT VIEW